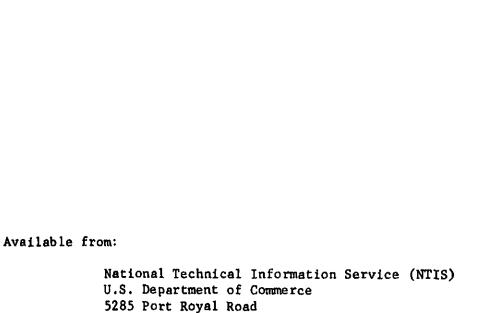
# Formerly Utilized MED/AEC Remedial Action Pro

Radiological Survey of the Museum of Science and 57th Street and Lake Shore Drive, Chica

Febr Fir

U.S. Departmen Assistant Secretary

Division of Environmental Cor Washingt



974 by the Atomic Energy Commission (AEC) for determination of the condition of the condition of the condition of the condition of the sites formerly utilized by the Manhattan Engineer District (MED) and the EC for work involving the handling of radioactive materials. Since the ear

This is one of a series of reports resulting from a program initiated :

940's, the control of over 100 sites that were no longer required for nucle rograms has been returned to private industry or the public for unrestricted.

se. A search of MED and AEC records indicated that for some of these sites

ocumentation was insufficient to determine whether or not the decontamination of the decontamination of the current guide ines.

This report contains the results of surveys of the current radiological condition of the Museum of Science and Industry, 57th Street and Lake Shore nicago, Illinois. Findings of this survey indicate there is no identifiable adioactivity remaining at this facility from operations conducted by the MECC during the period 1946 thru 1953.

This survey was performed by the following Health Physics personnel of ccupational Health and Safety Division, Argonne National Laboratory, Argon llinois: R. A. Wynveen, W. H. Smith, C. J. Mayes, P. C. Gray, D. W. Reilly

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# INTRODUCTION

Ouring the Manhattan Engineer District/Atomic Energy Commission (MED/AEC)
Argonne National Laboratory (ANL) occupied space at the Museum of Science
andustry, Chicago, Illinois. From August 15, 1946 until July 1, 1949, ANL

ied 36,000 square feet on the ground, first, and balacony floors of the Easion. From August 15, 1946 until July 15, 1953, ANL also occupied 16,000 e feet in the 2nd Balcony of the West Court. The actual use of the facility

re feet in the 2nd Balcony or the west court. The actual as the area was believed to be occupied as office as some handling of radioactive materials was known to have taken place.

Ti

and activity of these materials is unknown.

Personnel involved with the facility during ANL's occupation recalled at

t one spill of radioactive material near the service elevator on the ground

or of the East Pavilion and its subsquent decontamination.

Due to the uncertainty of the use of the facility, a radiation survey of the area was undertaken from January 11, 1977 until April 13, 1977. This survey area was undertaken from January 11, 1977 until April 13, 1977.

performed on an intermittent basis to minimize the disturbance of the Musly operations. The purpose of this survey was to determine if any detectabetamination remains as a result of the MED/AEC operation.

Part of the ground and main floors of the East Pavilion are presently occupied the University of Chicago for storage and office space or are used for support the Museum's operations. The 2nd Balcony of the West Court is now occupied

the Museum's operations. The Zha Barcon, or the Academy of Interscribe space by the Museum of Science and Industry and the Academy of Interscribe space by the Museum of Science and Industry and the Academy of Interscribe space by the Museum of Science and Industry and the Academy of Interscribe space by the Museum of Science and Industry and the Academy of Interscribe space by the Museum of Science and Industry and the Academy of Interscribe space by the Museum of Science and Industry and the Academy of Interscribe space by the Museum of Science and Industry and the Academy of Interscribe space by the Museum of Science and Industry and the Academy of Interscribe space by the Museum of Science and Industry and the Academy of Interscribe space by the Museum of Science and Industry and the Academy of Interscribe space by the Museum of Science and Industry and the Academy of Interscribe space by the Museum of Science and Industry and the Academy of Interscribe space space space by the Museum of Science and Industry and the Academy of Interscribe space spac

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All accessible original walls were surveyed to a height of seven feet a

# General

all accessible floor areas were surveyed. In many areas, the floors and wall had been retiled or painted. Even though these were not the original surfact these areas were surveyed since the capability of detection was adequate to activity on the original structures underneath. A representative selective

survey of overheads such as pipes, vents and light fixtures was performed in

where the original structures were available. The roof of the East Pavilion

# also surveyed. See Table 1 and Figure 1 for locations of accessible areas su

Three types of survey instruments were used (Table 2). An Eberline FM having a detection area of 325 square centimeters  $(cm^2)$ , utilizing the Eberli PAC-4G-3 electronics, was used to survey the floors. A PAC-4G-3 with a hand-detector,  $61cm^2$  in area, was used to survey the walls and other accessible are Double aluminized mylar  $\left[-0.85 \text{ milligrams per square centimeter } (mg/cm^2)\right]$ 

windows were used in both detectors. This allows for low energy detection and greater instrument sensitivity. Both of these instruments were initially used in the beta mode. In this mode, the detector responds to a wide energy range of electromagnetic and particulate radiations. When areas were found which in sated a higher count rate than the average instrument background, the instrume

as then switched to the alpha mode and a reading of the alpha activity was btained.

An End Window Geiger-Müeller (G-M) Detector, Eberline Model E-500B with a

ecial 7/8 inch diameter window held three feet above the floor, was used to do ne general background radiation levels throughout the surveyed area. If an around that had an elevated count rate, a contact reading was obtained.

t must be realized that the numerous isotopes that could be encountered xhibit emission energies differing from that of 239Pu and 90Sr-90Y utili calibration. When detecting known isotopes that emit alpha and beta es differing from that of the standards, a conversion factor is develope ermine the appropriate yield. Surveys mears were taken throughout the East Pavilion and West Balcony areas of . Only original structures and components such as walls, floors, pipes were smeared. All smears were taken with No. 1 Whatman filter paper, 4, eters (cm) in diameter. Smears of one square foot were normally taken. a was found which had a higher than normal background, a smear of 100cm2 A smear of 100cm<sup>2</sup> was also taken if an area indicated excessive dirt 1 ears were counted in groups of ten using the 10-Wire Flat Plate Cas tional Detector, developed at ANL, utilizing an Eberline Mini Scaler Mod

One smear of each group was removed and counted in a Nuclear Measuremen

ation Proportional Counter - 3A (PC-3A) 2m Internal Gas Flow Counter usi

r spun top. This procedure was used as an additional means of checking

samples. In addition, any smears indicating elevated amounts in the 10-

ly, were also counted in the more sensitive PC-3A counter. Smears were

d in both detectors for alpha and beta activity. Appendix I includes the

mentation and smear count conversion factors used.

um-226 (226Ra) calibration source. The PAC-4G-3 instruments were cali-

in the alpha mode using a flat plate infinitely thin Plutonium-239 (239

rd and in the beta mode with a flat plate infinitely thin Strontium-90-

m-90 ( $^{90}$ Sr- $^{90}$ Y) standard. The instruments were calibrated to an apparen

ometry.

r samples were taken at a flow rate of 15 cubic meters per hour  $(M^3/hr)$ Ocm<sup>2</sup> sheet of Hollingsworth-Vose (HV-70-9 mil) filter media which collec e particulates present in the air. A 10% portion, 5cm in diameter, was om the filter media and counted in the NMC PC-3A 2π Internal Gas Flow Co ilizing a mylar spun top for both alpha and beta activity. Sampling res re used to determine radon concentrations and the presence of any long-1 civity. Air sample data is presented in Appendix 2. .1 Samples In addition to the survey inside the building, soil corings were taken

hat smear in the room. A number, (n), indicates a smear of an overhead

A number n, indicates an elevated direct reading.

Air samples were collected using a Filter Queen air sampling device.

tructure.

ir Samples

n of the smears. A number, n, indicates the location

t Pavilion. Radiochemical (fluorometric) and gamma spectrum analysis we lucted on these soil samples. The corings were effected using a four (4) inch in diameter by six (6) ength right circular cylinder; commonly called a hole cutter. This devi ormally used for cutting holes for the cups in golf courses. Each core was 1 foot in length and divided into four (4) segments. Sta

ected locations outside the East Pavilion of the Museum to determine the

osition, if any, of isotopes that could have been spilled or released fr

the surface, three (3) separate two (2) inch segments are cut, bagged, ed A, B and C respectively; the final segment a six (6) inch section was ed D.

Background data for the soil sample analysis (Table 8) were obtained umber of soil samples taken from the Chicago area. This information was ained from the Environmental Monitoring Section of the Occupational Health ety (OHS) Division of ANL.

All soil samples were processed at ANL (Figure 3) and shipped to a commoratory (LFE Environmental Analysis Laboratories) for radiochemical uorometric) and gamma spectrum analysis. Their soil analysis procedure is ibed in Table 6.

Sample preparation consisted of weighing the samples in their entirety a

n drying for approximately 24 hours at 80° Centigrade. All samples were t

reighed, put into mill jars (2.3 gallon) and milled until a sufficient amou

t migration has occurred, to reduce the dilution of lower level soil with

er level segments in respect to the surface deposition of the contaminants

e versa, and to reveal any overburden or back fill that may have occurred

Three soil samples were taken from the grounds adjacent to the East Pavi

the Museum. Figure 1F indicates the soil sample locations.

r the years.

Table 5.

the soil sample would pass a No. 30 standard sieve. At no point were the heavy material ground or pulverized since this material would act as a dinence lower the concentration per unit volume of deposited material.

After sufficient milling, the material was sieved using a No. 30, 600 mi standard stainless sieve. The rocks and dross vs. sieved material (< 600 segregated, bagged, and weighed separately. Soil sample weights are given

radiochemical (fluorometric) only. Every effort was made throughout preparation operations to reduce or eliminate cross contamination. So which were suspected of containing elevated amounts of radioactivity processed in equipment separate from the soil samples considered to organize the samples. All items of equipment were scrubbed and air dried printroduction of the next sample.

# ANALYSIS OF SURVEY RESULTS

All data, including diagrams of survey locations, are attached

# <u>General</u>

different instruments used.

This section discusses the results of the survey and the findings the Instrument readings and smear results were normalized to units of discovered and square centimeters (dpm/100cm²). (See Appear the conversion factors used.) All data is reported in net count background counts have been subtracted from the gross counts prior to from counts per minute per one hundred square centimeters (cpm/100cm dpm/100cm². The beta mode readings are compensated for any alpha counts room background levels varied somewhat due to the construction must them. Table 3 provides an average background reading for all modes.

The areas accessible for survey varied from room to room. Area for survey are presented in Table 1. The average percent of the totareas was 50% for the floors and 40% for the walls.

Room C-340 - This room is a small instrument shop where a marked Cobactor was found in the cabinet. A direct reading with an End Windstector was 80 milliRoentgens per hour (mR/hr) at contact. When the detects held three feet away from the source in its shielded container, no radiove background levels, < 0.03 mR/hr, could be detected.

Room E-201 and Restrooms on 2nd Balcony - These washrooms contained a le on the floors. This tile was also noted in other restrooms of the Muster of the Mu

arr indicated areas were surveyed and no radioactivity above backgrou

the beta mode. No alpha activity was detected. No radiation above back vels could be found from the tile using the End Window G-M Detector. No tivity was detected from floor tile smears. It was determined from a gasectral analysis that the tile contained elevated amounts of (40K) which was an elevated reading. (See Figure 2 for gamma emission spectra.) A negal background readings taken at three feet above the floor level were

ectral analysis that the tile contained elevated amounts of (40K) which use an elevated reading. (See Figure 2 for gamma emission spectra.) A neral background readings taken at three feet above the floor level were an 0.03 mR/hr.

Ear Surveys

No contamination above background levels was detected on any smears.

The air sampling results are presented in Table 4. The variation of the samples are presented in Table 4.

ults do not appear to be a result of any MED/AEC operation, but rather to on reflects the differences in the construction materials used throughout ility. Other factors such as the ventilation of the room can cause the

trations to vary. All radon concentrations determined are below the max e concentrations (MPC) for an uncontrolled area as listed in the "Standa

e concentrations (MPC) for an uncontrolled area as listed in the "Standa tection Against Radiation," Code of Federal Regulations, Title 10, Part

Results submitted by LFE Environmental Analysis Laboratories, as listed in 7, are reported in picocuries per gram (pCi/g) for the Germanium (Lithium)

Samples

Li) spectral analysis and in micrograms per gram ( $\mu g/g$ ) for the uranium cometric analysis. The latter concentrations were converted to pCi/g by mea ne example calculation as shown in Appendix 3.

The background data is presented in Table 8. The background samples indica al uranium concentrations ranging from 0.03 to 2.0 pCi/g. Results of soil les taken at the Museum of Science and Industry indicate a gerneral normal u ground concentration in the soil.

FINDINGS

The survey results show that no radioactive contamination above background cted throughout the areas used for MED/AEC activities. However, a small  $^{60}\mathrm{C}$ ce which was used as a static eliminator was found in Room C-340. The floor s which were used in the restrooms, showed elevated levels of naturally occu  $^{40}$ K. Neither of these are a result of any MED/AEC operations. The results soil sample analysis shows no elevated readings above the natural background

ls present in the soil from this region.

L			├										•	,								,	91
	Smear	Results (dpm/100cm <sup>2</sup> )		RKGD	7	BKCD	BKGD	BKCD	BKCD	BKCD	BKGD	BKGD	BKCD	BKCD	. [	BKGD	BKCD	BKGD	BKGD	BKGD	BKGD	BKCD	1212) Floor and wall
	MO.	II) 2 feet			BKGD	BKGD	BKGD	EKGD	BKGD	BKGD	BKCD	BKGD	BKGD	אניים		BKCD	BKGD	BKGD	BKGD	BKGD	BKCD	BKGD	10110
	Fnd Window	(mR/hr)	Contact			NN	N.	N	N.	NN	NN	NN.	NN.	;	ZZ.	Ř	NN	NN	NN	NN	NN	N	
	:		Ther		NA	NA	NA	NA	NA	NA	NA	ΑN	1 3	NA.	NA	NA	NA	NA	NA	NA	NA	NA	-
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TOTAL W		ngs	<del>-</del> ا	T	12 Z	(5)	N.	BKGD	BKGD	E E	BKGD	EX	EN	別	<u> </u>		ı Z	邕	閔	일	BKGD	E I	ME
7 <b>.</b> 4.7		de (1) Direct Readings	Cm <sup>2</sup> )	Overnead	(#)	OSO.	nso	OST	oso	nso	nso	BKGD	BKCD	BKCD	68		nso	BKGD	BKGD		BKGD		BKGD
		le (1) Di	(dpm/100	Walls		BKGD	BKGD	BKGD	BKGD	BKCD	BKCD	BKGD	BKGD	BKGD		BKGD	BKGD	BKCD	BKCD	BKGD	BKGD	BKCD	BKGD
		Refa Mode (1)	•	Floors		BKGD(3)	BKGD	вксо	BKGD	BKGD	BKGD	BKGD	BKGD	RKGD		BKGD	BKGD	BKGD	BKCD	BKGD	BKGD	BKGD	BKCD
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Room or Area No.

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1-3 E-2

E-19 E-18

E-16 E-17

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E-12

E-11

E-9 원 원 E-7

(6) NA (Not Applicable) No activity detected above backs

(5) NE (Non-Existant)

therefore, no alph mode survey was necessary.

(7) ... Manaceare) No activity was detected; therefor

Alpha Hode 0-50 cpm/325cm<sup>2</sup>

(3) BKGD (Background) Instrument Background Readings

1500-2000 com/325cm<sup>2</sup>

Thor Monitor

Beta Mode

 $<sup>^{(1)}</sup>$  Beta Mode detects both electromagnetic and particulate radiation.

 $<sup>^{(2)}</sup>_{
m NS}$  – (Not Selected) Air sample locations were chosen on a selected basis throughout the areas surveyed.

<sup>(4)</sup> OSU (Overhead Stucture Unavailable) Floor and wall sur necessity to demolish existing structures to reach ori This location did not contain stru as "other" such as the following: ducts, louvers, pi

Comments

(dpm/100cm<sup>2</sup>) Results

3 feet

Contact (7)NN

Other

Floors (6) NA (6)

Overhead | Other

Beta Mode (1) Direct Readings

(dpm/100cm<sup>2</sup>)

Walls

Floors

Sample

Wall

Survey Floor

SE OF

Air

Percent of Area Accessible for

Smear

End Window (国/hr)

> Alpha Mode Direct Readings Walls Overhead (dpm/100cm<sup>2</sup>)

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0-50 cpm/61cm<sup>2</sup>

150-200 cpm/61cm<sup>2</sup>

Ploor Monitor

PAC-4G-3

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(7) M (Not Macessary) No artivity was detected: therefore, no contact

therefore, no alpha mode survey was necessary.

basis throughout the area surveyed.

Alpha Mode 0~50 cpm/325cm<sup>2</sup> 3) BKGD (Background) Instrument Background Readings. 1500-2000 cpm/325cm2 Beta Mode

<sup>(2)&</sup>lt;sub>NS-</sub>(Not Selected) Air sample locations were chosen on a selected

<sup>(5)</sup> NE (Non-Existant) This location did not contain structural items of as "other" such as the following: ducts, louvers, pipes and vents.

BKCD

<sup>(6)</sup> NA (Not Applicable) No activity decected above background in the b

<sup>(4)</sup> OSU (Overhead Structure Unavailable) Floor and wall survey indicat necessity to demolish existing structures to reach original overhe

Ĭ	Percent of Area	of Area	3 5 6	α to to	Reta Mode (1)	irect Read	lnes	Aloha M	fode Dir	Alpha Mode Direct Readings	SZ		:		
H 0	Survey Floor	[Na1]	Sample (pCi/2)	Floors	(dpm/100	100cm <sup>2</sup> )	Other	Floors	(dpm/1 Walls	(dpm/100cm <sup>2</sup> )	Other	ပိ	/hr) 3 feet	Results (dpm/100cm <sup>2</sup> )	Comments
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	80	90	BLGD	BKGD	BKCD	BKGD	BKCD	ΑX	NA A	NA	NA	NN	BKGD	BKGD	
	20	10	NS(2)	BKCD	BKCD	BKCO	BKCD	NA	ΝΆ	NA	NA	N.	BKGD	BKCD	
E S D	50	20	NS	BKCD	BKGD	BKGD	BKGD	NA	NA A	NA	<b>₹</b>	NN	BKCD	BRGD	-
	80	20	1.04	8.3x10 <sup>3</sup>	BKCD	OSO	¥	BKCD	ΝΑ	NA	N.A	BKGD	BKCD	BKCD	Floor tile in was
	20	30	0.67	ВКСО	BKCD	BKCD	9	NA	NA	NA	NA	NN.	BKCD	BKGD	
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	09	05	NS	8.3x10°	BKCD	BKGD	μl Z	BKCD	e V	Ą	ş		n n	1	
	08	10	MS	BKGD	BKCD	OSU	9.6x10 <sup>2</sup>	NA	M.	¥¥.	BKCD	80	BKGD	NST (8)	60 Co Source Read
	980	20	SN	BKCD	BKGD	nso	BKGS	NA	ΝΑ	NA	Ą.	NN	вксо	BKCD	
	<b>-</b> 09	7 07	- NS	BKGD .	BKGD	nso	BKCO -	¥.	- VN	- W	- W	- - -	BKCD	BKGD	-
eta E	ode dete	sets both	n electrom	eta Mode derects both electromagnetic and par	nd parti	ticulate radiation	iation.		(4)08	(4) OSU (Overhead	3 Struc	Structure Unavailable)	nilable)    structu	OSU (Overhead Structure Unavailable) Floor and wall survey necessity to demolish existing structures to reach original	Floor and wall survey indicate ures to reach original overhead
S - (	Not Sele through	ected) As	<ul><li>S - (Not Selected) Air sample locatesis throughout the areas surveyed.</li></ul>	<ul> <li>(Not Selected) Air sample locations were its throughout the areas surveyed.</li> </ul>		chosen on a	selected		(5) Ne	(Non-Exist	tant) I	(Non-Existant) This location of	on did no	t contain stri	
Ę	Booker	nd) Inch	age to the	my (Respectively Testiment Respections) Deskines	Danking				9	o tamer	20 113			, , , , , , , , , , , ,	
3	0.000	(511	Beta Mode	le le	A. A	Alpha Mode			(6) th	NA (Not Applicable) No activity detected above therefore, no alpha mode survey was necessary.	icable) o alpha	No activi mode surv	ity detect	ed above back cessary.	(6) NA (Not Applicable) No activity detected above background in the beta therefore, no alpha mode survey was necessary.
1001	loor Monitor	1	500-2000	1500-2000 cpm/325cm <sup>2</sup>		0-50 cpm/325cm <sup>2</sup>			(2)	Monow Woney		No serient	m une det	poted. theref	(Mar Manager) No arrivers as defected; therefore, no contact G-
AC-4C-3	£.		150-200 com/61cm	pm/61cm <sup>2</sup>	0-50	0-50 cpm/61cm <sup>2</sup>				NN (NOL MECEN Lindon Survey	5561 y , II was n	M was necessary.	וא אפט מכנ		

Air Beta Mode (1) Direct Readings Alpha Mode Direct Readings End Window Smear (dpm/100cm²) (dpm/100cm²) (mR/hr) Results	2 2
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						īøā	A SHEETS	TABLE I S SHOWING ROO	L ROOM STU	TABLE I DAIA SHEETS SHOWING ROOM SURVEY RESULIS	s,	ļ	į		
Room or	Percent of Area Accessible for Survey	!	Air Sample	Beta M	lode (1) Direct (dpm/100cm <sup>2</sup> )	Beta Mode <sup>(1)</sup> Direct Readings (dom/100cm <sup>2</sup> )	sgaj	Alpha M	fode Direct Re	Alpha Mode Direct Readings (dom/100cm²)	57. 57.	End Window (mR/hr)	dow hr)	Smear Results	
Area No. Floor	Floor	Wall	(pCi/t) Floors	7	Walls	Overhead	Other	Floors	Walls	Overhead	Other	Contact	3 feet	Walls Overhead Other Floors Walls Overhead Other Contact 3 feet (dpm/100cm²)	Comments
C-343 C-244A	1.5	15	NS(2)	BKGD <sup>(3)</sup>	KGD CD	(†) <sup>ΩSO</sup>	BKCD	(6)	X.	NA	NA NA	(2)	BKGD	BKGD	

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 $^{(1)}$  Beta Mode detects both electromagnetic and particulate radiation

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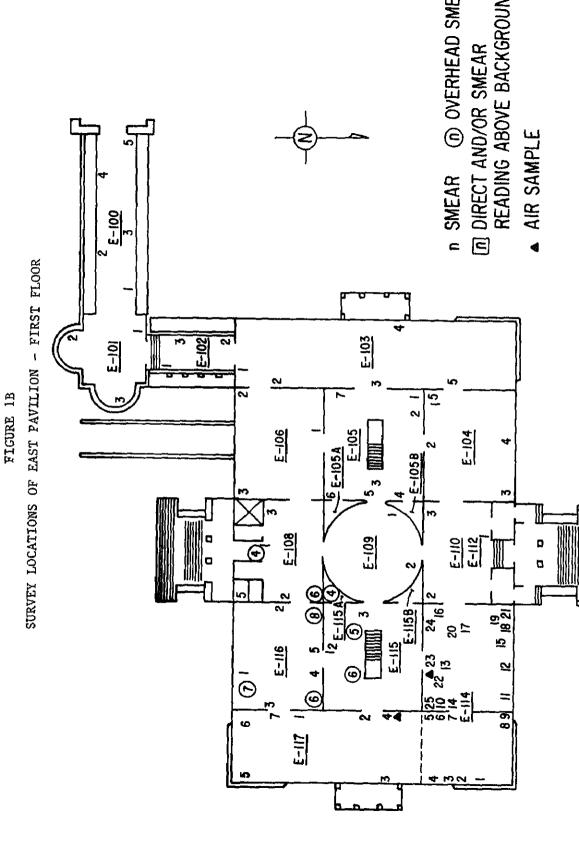
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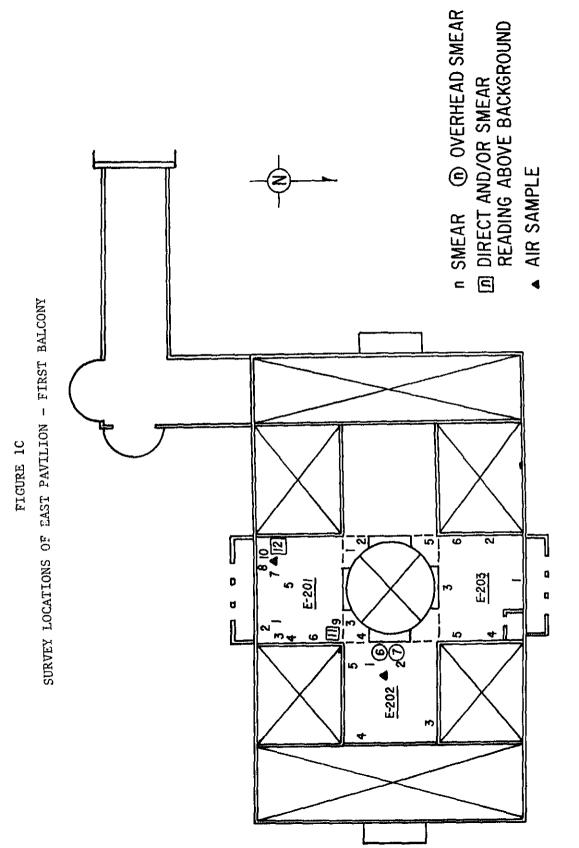
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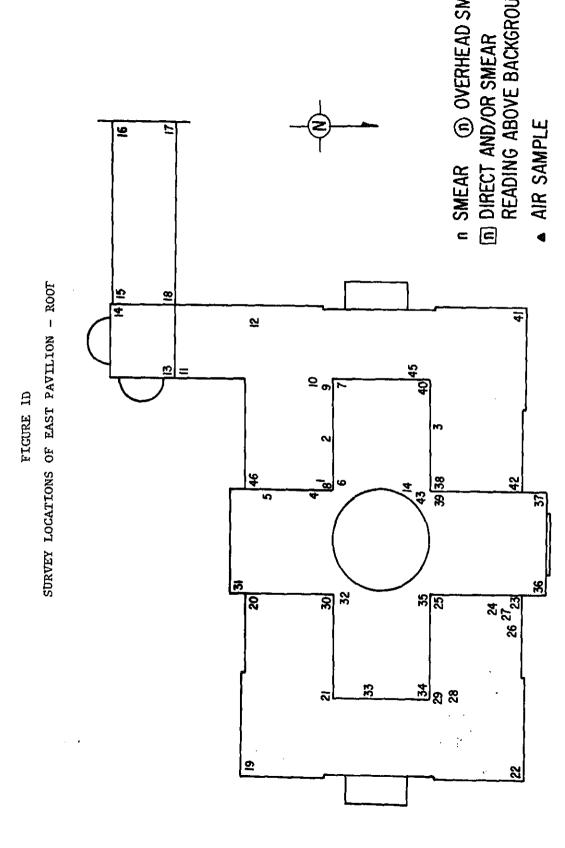
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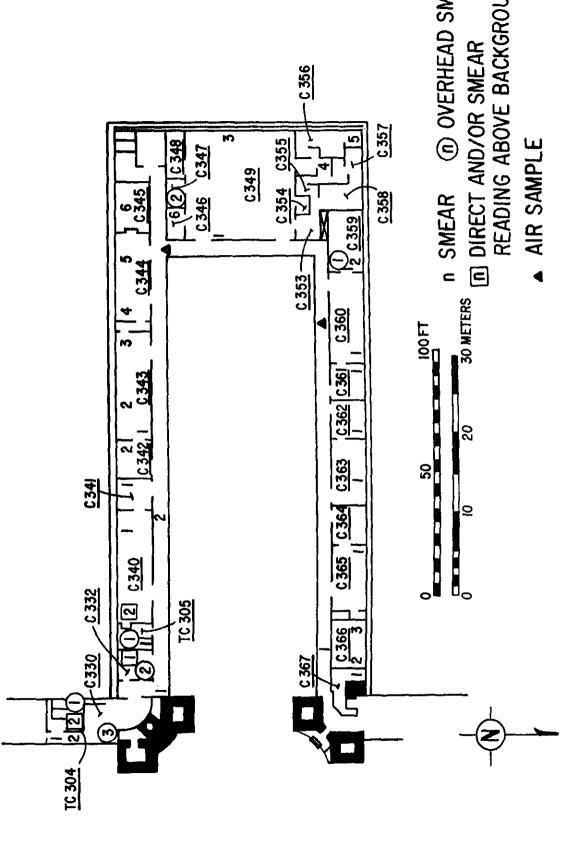
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C-345









# INSTRUMENTATION USED IN SURVEY

Туре

tilizing a PAC-4G-3

berline Floor Monitor FM-4G

Inventory Number

181501

Window

0.85 mg/c

Probe Area

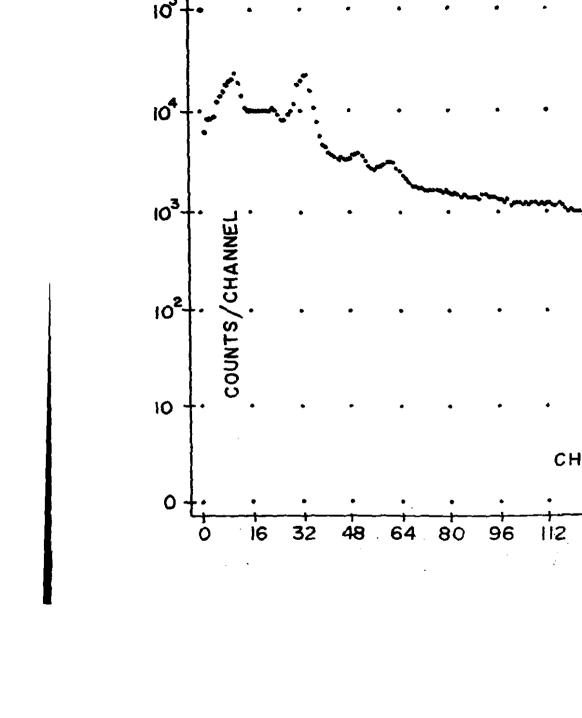
325cm<sup>2</sup>

berline Floor Monitor FM-4G itilizing a PAC-4G-3	181581	325cm <sup>2</sup>	"
AC-4G-3	165251	$61cm^2$	11
п	165252	11	11
11	165255	11	п
11	165256	11	11
n	183413	11	ff
II	183414	11	11
Bberline HP-90 Beta-Gamma End Window	159006	-	1.4 - 2m;
Nuclear Measurement Corporation PC-3A-2π Internal Gas Flow Counter	114969	-	0.85mg/
Argonne National Laboratory Filter Queen Air Sampler using HV-70 filter media	~	-	
Argonne National Laboratory 10 Wire Flat Plate Gas Proportioal Detector with Eberline Mini Scaler MS-2	184343	-	0.85mg/

# INSTRUMENT BACKGROUND READINGS

Instrument Eberline Floor Monitor FM-4G using PAC-4G-3	Reading Alpha Mode (cpm)	s* Beta Mode (cpm)
#181501 . #181581	0 - 50 0 - 50	1500 - 2000 1500 - 2000
PAC-4G-3		
#165251 #165252 #165255 #165256 #183413 #183414	0 - 50	150 - 200
Eberline HP-90 Beta-Gamma End Window	<b>`</b> .	
Nuclear Measurement Corporation PC-3A-2π Internal Gas Flow Counter	0.4	50
Argonne National Laboratory 10 Wire Flat Plate Gas Proportional Detector with Eberline Mini Scaler MS-2	10	-500

<sup>\*</sup>Background readings were initially taken in the mobile laboratory and throughout the various areas inside the Museum of Science and Indust surveying.



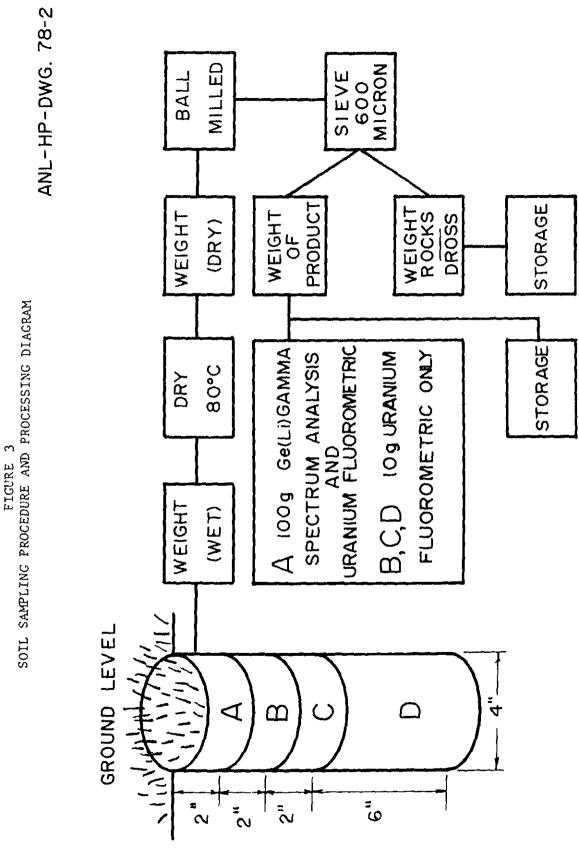
### RADON CONCENTRATION DETERMINATIONS

Location	$dpm/M^3$	<u>pCi/1</u>	% of MPC*
E-2	2744	1.25	42
E-14	1057	0.48	16
E-15	1057	0.48	16
E-18	3372	1.5	51
E-114	1075	0.49	16
E-117	1567	0.71	24
E-201	2277	1.04	35
E-202	1476	0.67	22
South Hall (2nd Balcony West Court)	683	0.31	10
North Hall (2nd Balcony West Court)	671	0.31	10

\*The 10CFR20 MPC for Radon-222 ( $^{222}\text{Rn}$ ) in an uncontrolled area i. 3 x  $10^{-9}$  µCi/cc which equals 3 pCi/l.

# Example Calculation Room E-15

1057 dpm/M<sup>3</sup> x 
$$\frac{1 \text{ pCi}}{2.22 \text{ dpm}}$$
 x  $\frac{\text{M}^3}{10^3 1}$  = 0.48 pCi/1



# SOIL SAMPLE WEIGHTS

Sieved Weight

(grams)

666.0

1563.3

Rocks and I

Weight (gra

145.0

222.9

Dry Weight

(grams)

688.9

Net Weight

(grams)

887.8

2142.2

ample No,

P-1A

P-3D

3.5	551.6	582.0	749.0	P-1B
13.5	557.2	579.6	740.8	P-1C
94.3	1161.8	1281.8	1642.2	P-1D
55.3	376.0	435.2	616.1	P-2A
44.7	541.1	593.5	764.8	P-2B
60.0	766.4	833.0	1050.0	P-2C
189.7	1750.0	1944.5	2375.3	P-2D
72.2	417.1	495.9	677.8	P-3A
65.3	649.3	717.2	907.2	P <b>-3</b> B
26.9	750.4	785.5	962.3	P-3C

1800.5

ADDA 0

LFE SOIL ANALYSIS PROCEDURE FOR TOTAL URANIUM AND GAMMA-EMITTING NUCLIDES

# ary of Methods

for 500 minutes on a Ge(Li) detector over the energy range 0 - 1.5 MeV. corresponded to between 60 to 100g of soil, depending upon bulk soil den

A 60 milliliter (ml) volume of the received soil was counted in a petri

efficiency curve based upon a National Bureau of Standards Multi Gamma dard. The natural Thorium-232 (232Th) and 226Ra decay chains were calcul

tive photopeaks above instrument background were converted to dpm using a

using the 0.910 MeV Actinium-228 (228Ac) and 0.609 MeV Bismuth-214 (214Bi opeaks respectively. Cesium-137 is reported for each sample as a representation and emitter. Potassium-40 (40K) was observed on all soil samples, as

cted, but was not calculated or reported.

ium analysis. A 100-λ aliquot of the dissolved sample was fused with 985 2% LiF and the fluorescence determined using a Jarrell-Ash fluorometer. ching factor was determined for each sample by using an internal spike.

One gram of the soil sample was ashed and dissolved in HF-HNO3 for the

<sup>232</sup>Th Decay Chain

Ge(Li) SPECTRUM AND URANIUM FLUOROMETRIC ANALYSES RESULTS

<sup>226</sup>Ra Decay

Chain

 $0.93 \pm 0.09$ 

μg/g.± σ

1.9±0.4

2.6±0.4

0±0.2

EP-1A	1.43 ± 0.07	$0.8 \pm 0.2$	$0.75 \pm 0.08$	3.5±0.4
EP-1B				2.6±0.4
EP-1C				1.3±0.4
EP-1D				3.1±0.4
EP-2A	$0.98 \pm 0.05$	0.9 ± 0.1	$0.83 \pm 0.07$	2.2±0.4
EP-2B				2.2±0.5
EP-2C				1.9±0.6

137<sub>Cs</sub>

EP-2D

EP-3A

EP-3B	3.5±0.5
EP-3C	4.1±0.5
EP-3D	2.4±0.4

 $1.05 \pm 0.06$   $0.6 \pm 0.2$ 

LFE Blank  $0 \pm 0.06$  $0 \pm 0.1$  $0 \pm 0.06$ 

One standard deviation due to counting statistics.

**(1)** (2) Data Results from LFE.

(3) ANL Conversion from Appendix 3.

BACKGROUND SOIL SAMPLE DATA\*

Date Collected	Location	Cesium-137	Thorium-232
July 22	Argonne Area	0.3 ± 0.1	0.21 ± 0.04
July 22	Argonne Area	0.1 ± 0.1	$0.49 \pm 0.04$
July 22	Argonne Area	0.3 ± 0.1	0.48 ± 0.04
October 18	Argonne Area	0.1 ± 0.1	0.65 ± 0.07
October 18	Argonne Area	0.3 ± 0.1	$0.43 \pm 0.04$

Argonne Area

McKinley Woods

State Park, IL

McCormick Woods Brookfield, IL

Bemis Woods

Hinsdale, IL

Dresden Lock &

Average

Dam, IL

St. Joseph, MI

Willow Springs, IL 0.5 ± 0.2

Average

Off-Site

ctober 18

June 22

June 23

June 23

ctober 12

ctober 13

ctober 14

concentrations in pCi/g

Cesium-137, Thorium, and Uranium in Soil 1976

 $0.4 \pm 0.1$ 

 $0.2 \pm 0.1$ 

 $0.4 \pm 0.1$ 

 $0.3 \pm 0.1$ 

 $0.4 \pm 0.1$ 

 $0.4 \pm 0.1$ 

 $0.4 \pm 0.1$ 

 $0.4 \pm 0.1$ 

ese results are transcribed from "Environmental Monitoring at Argonne Nat poratory Annual Report for 1976" (ANL-77-13) by N. W. Golchert, T. L. Duf Sedlet. These measurements are presented in Table 13, on page 47 of the

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 $0.39 \pm 0.04$ 

 $0.44 \pm 0.14$ 

 $0.16 \pm 0.02$ 

 $0.22 \pm 0.02$ 

 $0.18 \pm 0.01$ 

 $0.20 \pm 0.02$ 

 $0.45 \pm 0.03$ 

 $0.24 \pm 0.14$ 

#### CONVERSION FACTORS

#### INSTRUMENTATION

Below are the conversion factors used to obtain the readings in disintegrations per minute per  $100 \text{cm}^2$  (dpm/ $100 \text{cm}^2$ ).

# I Conversion Factors

	Floor Monitor (FM-4G)	PAC-4G-3
To 100cm <sup>2</sup>	0.31	1.6
cpm to dpm (alpha)	2	2
cpm to dpm (beta)	2	2
com to dom (K <sup>40</sup> )	<del>-</del>	16.5

### II Derivation of Conversion Factors

## Floor Monitor (FM-4G)

Window Area: ~325cm<sup>2</sup>

Conversion to  $100 \text{cm}^2 = .31$  times floor monitoring reading

### PAC-4G-3

Window Area: -61cm<sup>2</sup>

Conversion to 100cm<sup>2</sup> = 1.6 times PAC reading

# 2π Internal Gas Flow Counter, PC-3A

Geometry: Mylar Spun Top - 0.43

Mylar Spun Top Counting (window double aluminized m mg/cm<sup>2</sup>) utilizes the well of the PC-3A and is a met and used by the Argonne National Laboratory Health Section for negating the dielectric effect in count on non-conducting media.

The conversion factors for cpm/100cm<sup>2</sup> to dpm/100cm<sup>2</sup> are given below.

# I CONVERSION EQUATION (ALPHA)

om-Bkgd x bf x sa x waf = dpm Alpha

om - (Beta Bkgd + Alpha cpm) = dpm Beta

x bf x sa x waf

lter media.

geometry (g) of 0.43 is standard for all flat plate counting.

backscatter factor (bf) of 1.0 is used when determining alpha activity of filter media.

ne self-absorption (sa) was assumed to be I unless otherwise determined.

the energies of the isotope were known, the appropriate window air fact vaf) was used; if the energies of the isotopes were unknown the waf of  $^{23}$ 

ních is .713, was used.

# II CONVERSION EQUATION (BETA)

geometry (g) of 0.43 is standard for all flat plate counting. backscatter factor (bf) of 1.1 is used when determining beta activity on

e self-absorption (sa) was assumed to be 1 unless otherwise determined.

the energies of the isotopes were known, the appropriate window air fac-

raf) was used; if the energies of the isotopes were unknown, the waf of

Sr-90Y, which is 0.85 was used.

## RADON DETERMINATION

llected using Argonne National Laboratory designed air sampler with HV-70 lter media. The attachment includes the basic assumptions and calculators used to derive the air concentrations.

This attachment summarizes the air sampling calculations for samples

Radon Concentrations Based on RaC' Results

The following postulates are assumed in deriving the Radon-222 (222Rn) concentrations as based on the RaC' alpha count results.

1. RaA, RaB, RaC, RaC', are in equilibrium.

decay count.

5.

mode.

- 2. RaA is evident only in the first count and not the 100 minute
- That one-half of the Radon progeny is not adhered to airborne particulate, and therefore, not evident on the filter media.
- 4. The geometry factor (g) is 0.43 for both the alpha and beta activity.

The backscatter factor (bf) of 1.0 is used for the alpha

- 6. The sample absorption factor (sa) for RaC' is 0.77.
- 7. The window air factor (waf) for RaC' is 0.8.

activity which is determined from RaC'.

- 8. RaB and RaC being beta emitters, are not counted in the alpha
- 9. The half-life of the Radon progeny is approximately 36 minutes, based on the combined RaB and RaC half-lives.
- 10. No long-lived alpha emitters present as evidenced by the final
- recount.
- 11. For all practical purposes, RaC' decays at the rate of the composit of RaB and RaC which is approximately 36 minutes.

### RADON DETERMINATION (cont'd.)

II. Equations Used to Derive Air Concentrations

$$N_{O} = \frac{N}{-\lambda t}$$

Where:  $N_0 = Activity$  present at the end of the sampling pe

N = Activity at some time interval, after end of s

t = Time interval N to N

$$\lambda = \frac{.693}{t_{1}}$$

 $t_{l_s}$  = Half-life of isotope

$$C = \frac{A \lambda}{f} \frac{1}{(1-e^{-\lambda t})}$$

nere: C = Concentration per unit volume

A = Activity of filter media at end of sampling pe (No from previous equation)

f = Sampling rate (M<sup>3</sup>/minute)

t = Time sampling was taken

$$\lambda = \frac{.693}{t_{1}}$$

 $t_{i_2}$  = Half life of isotope or controlling parent

# RADON DETERMINATION (cont'd.)

Example Calculations - Room E-15

$$N_o = \frac{498 \text{ dpm}}{e^{-.693 \times 104}} = 3687 \text{ dpm}$$

$$C = \frac{3687 \times \frac{.693}{36}}{15/60} \frac{1}{1 - e^{-\frac{.693 \times 40}{36}}} = 529 \text{ dpm/M}^{3} \times 2 = 1057 \text{ dpm/M}^{3}$$

CATION: MU	MUSEUM OF S	SCIENCE	AND	INDUSTRY E-	E-2				SAME	SAMPLE COLLECTION DATE:	TION DATE		4/15/77
						,			TIME	양	COLLECTION: 1	1242	
									SUSF	SUSPECTED ISO	ISOTOPE: Un	ident	Unidentified
NGTH OF RUN:	TIME	TOPPE	STOPPED 1322	MINUS	TIME STARTED	TED	1242	TOTAL	L TIME	70	MINUTES		
LUME: COLLE	COLLECTION RATE	TE 60	15 M <sup>3</sup>	/hr X TOTAL	AL TIME	40	MIN	MINUTES	= VOLUME	10	 ~∑_		
			GROSS	COUNTS	BKGD	NET	ł		28				
		Sila	·UTA	'A'Z.	·NIV.	'NZ)	<u> </u>	PA A	OLOLICAN	dOJON4	* §		A.I.I.A.I.I
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			20			$\int_{0}^{\infty}$		Vs .	TA	70		•	aq.
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1502	74	7	37	0.03	37	.43	Ţ	11.	8.	1396	140	ಶ	100 min.
1300	0	2	0	0.5	BKGD.	.43	1	77.	φ.	BKGD.	BKGD.	ర	6 days
1326	2114	2	1057	47.3 + 59	590.7	.43	1.1	-	.95	21,174	2117	σ2	4 min.
1504	634	2	317	47.3 + 37	232.7	.43	1.1	-7	.95	5182.6	518	8	102 min.
1300	80	2	40	53.3	BKGD.	.43	1.1	,.,	.95	BKGD.	BKGD.	82	6 days
HA:			81	BETA: Pure	Beta	emitters	} "	Ŝ	COMPOSITE:	Beta	determination	, io	1
cpm - Bkdg	50	= dp#	dpm Alpha	Cpm - B	Bkgd	ip = -	dpm Beta		cpm - I		+ Alpha	티	dom Rate

					VT CNS I IV	97 V							
					AIR SAMPLE	LE DATA							
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									TIME	OF.	COLLECTION: 10	1046	
			·						SUSP	SUSPECTED ISO	ISOTOPE: 11	Inidontif	† †
LENGTH OF RUN:	TIME	STOPPED	1126	MINUS	TIME STARTED	]. ]	1046	TOTAL	C TIME		E		77-17
VOLUME: COLLI	COLLECTION RATE	闰	15 M <sup>3</sup> /	/hr v TOTAL	AL TIME	70	MIM	MINUTES		0.7	eri		
		9		ব					= VOLUME	04	È,		
		\	GROSS	COUNTS	BKGD	NET			3				
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DATE AND TIME	OF	S.I.Wo.	TW TWI.	'ATA	NIN	NIW	12	YELLEY	d'dOSB1	V.J. D.			\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
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2/1 1135	176	2	88	0.3	87.7	.43	I	77.	8.	311	331	ಶ	9
2/1 1315	27	2	13.5	0.3	13.2	.43		77.	ω.	867	50	ಶ	10
4/21 1300	0	2	. 0	0.5	BKGD	.43	1	.77	ω.	BKGD	BKGD	ರ	79
2/1 1133	606	2	455	91.6 + 88.	275.4	.43	1.1	П	.95	6133	613	82	7 1
2/1 1313	384	2	192	91.6 + 13.5	85.9	.43	1.1	П	.95	1935	7	8	10
7/21 1300	8,9	2	37,	53 5	PVCD	67	-	-	20	n,	E AM	,	1

THE OF CALL THE STOPPED 1229 MINUS TIME STARTED 1149 TOTAL TIME 40  MILECTION RATE 15 M <sup>3</sup> /hr x TOTAL TIME 40 MINUTES = VOLUME 10  GROSS COUNTS BKCD NET CALL TOTAL TIME 40  INE OF CALL THE 40 MINUTES = VOLUME 10  AND CALL TOTAL TIME 40  INE OF CALL THE 40 MINUTES = VOLUME 10  AND CALL THE 40 MINUTES = VOLU	KLION: MUSEUM	TOC JO MO								TIME 0	OF COLLECTION	TON: 1149	6,	
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AND TIME OF SS FY SS		`	S,	UIW		·NIW	NIW		TER	d'HOS	Y 37	` `		10 V
1233 179 2 89.5 0.3 89.2 .43 1 .77 .8 3366 337 1413 27 2 13.5 0.5 BKGD .43 1.1 1 .95 6256 626 1235 929 2 462 +89.5 280.9 .43 1.1 1 .95 8KGD BKGD 1415 291 2 145.5 +13.5 40.4 .43 1.1 1 .95 8KGD BKGD 1415 291 2 145.5 +13.5 40.4 .43 1.1 1 .95 8KGD BKGD 1415 291 2 145.5 +13.5 24.0 BKGD .43 1.1 1 .95 8KGD BKGD 1415 291 2 145.5 Pure Beta emitters  Cpm - Bkdg = dpm Alpha  Cpm - Bkdg = dpm Alpha  Cpm - Bkdg = dpm Beta Right - Alpha Cpm - Beta Bkgd + Alpha Cpm - Bkdg = dpm Beta Right - Alpha Cpm - Bkdg = dpm Beta Right - Alpha Cpm - Bkdg = dpm Beta Right - Alpha Cpm - Bkdg = dpm Beta Right - Alpha Cpm - Bkdg = dpm Beta Right - Alpha Cpm - Bkdg = dpm Beta Right - Alpha Cpm - Bkdg = dpm Beta Right - Alpha Cpm - Bkdg = dpm Beta Right - Alpha Cpm - Bkdg = dpm Beta Right - Bkdg = dpm Beta Right - Alpha Cpm - Bkdg = dpm Beta Right - Alpha Cpm - Bkdg = dpm Beta Right - Alpha Cpm - Bkdg = dpm Beta Right - Alpha Cpm - Bkdg = dpm Beta Right - Alpha Cpm - Bkdg = dpm Beta Right - Alpha Cpm - Bkdg = dpm Beta Right - Alpha Cpm - Bkdg = dpm Right - Alpha Cpm - Bkdg = dpm Right - Bkdg = dpm Right - Bkdg = dpm Right - Alpha Cpm - Bkdg = dpm Right - Bkdg = dpm Right - Alpha Cpm - Bkdg - Alpha Cpm - Bkdg = dpm Right - Alpha Cpm - Bkdg - Alpha Cpm - Alph	AND TIME			JWI.		\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \		XYZ	ZV2	AP.		•		1 Ab
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233         179         2         89.5         0.3         89.2         .43         1         .77         .8         498           413         27         2         13.5         0.3         13.2         .43         1         .77         .8         498           300         1         2         0.5         8KGD         .43         1.1         1         .95         6256           235         929         2         462         +89.5         280.9         .43         1.1         1         .95         899           [415         291         2         40.4         .43         1.1         1         .95         8KGD           [415         291         6         40.4         .43         1.1         1         .95         8KGD           [415         2         43.5         54.0         BKGD         .43         1.1         1         .95         BKGD           pm - Bkdg         2         43.5         54.0         BKGD         .43         1.1         1         .95         BKGD           pm - Bkdg         2         43.5         54.0         BKGD         .43         1.1         1         .95			<b>2</b>	2			;	-	1,	8		337	ರ	4 min
413 27 2 13.5 0.3 13.2 .43 1 .77 .8 498  300 1 2 0.5 8KGD .43 1.1 1 .95 8EGD  235 929 2 462 +89.5 280.9 .43 1.1 1 .95 829  [415 291 2 145.5 +13.5 40.4 .43 1.1 1 .95 8KGD  87 291 2 43.5 54.0 8KGD .43 1.1 1 .95 8KGD  PM - Bkdg = dpm Alpha	1233	179	2	• 1	0.3		3	1	1			Č	·	10% min
300 1 2 0.5 BKGD .43 1.1 1 .95 BKGD .280.9 .43 1.1 1 .95 6256 .235 929 2 462 +89.5 280.9 .43 1.1 1 .95 6256 .235 .291 2 145.5 +13.5 40.4 .43 1.1 1 .95 899 .899 .87	6.7.	7.6	,		0.3	•	.43	_	17	8.	867	2	B I	•
300 1 2 0.5	1413	77	, (	u c		BKCD	.43	,I	.77	∞.	BKGD	ВКС	ಶ	79 days
235 929 2 462 + 89.5 280.3 .43 1.1 1 .95 899  [415 291 2 145.5 + 13.5 40.4 .43 1.1 1 .95 899  [87 2 43.5 54.0 BKGD .43 1.1 1 .95 BKGD BETA: Pure Beta emitters    Pur - Bkdg	1300	<sub>p-1</sub>	7		91.	000	6,7		-	.95	6256	626	B	6 min
415   291   2   145.5   + 73.5   40.4   .43   1.1   1   .95   057     87   2   43.5   54.0   BKGD   .43   1.1   1   .95   BKGD     BETA: Pure Beta emitters   COMPOSITE: Beta Bkgd   Cpm - Bkdg   Cpm - Bkdg   Cpm - Bkgd   Cpm - Bkdg   Cpm - Bkgd   Cpm - Bkg	1235	929	7	462	<u>وا</u> 3	780.9	-	• 1	,	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	000	é	8	106 min
87   2   43.5   54.0   BKGD   .43   1.1   1   .95   BKGD   BKGD   .43   BETA: Pure Beta emitters   COMPOSITE: Beta   Cpm - Beta Bkgd   Cpm - Bkgd   Cpm - Beta Bkgd   Cpm - Bkgd   Cpm - Beta Bkgd   Cpm - Bkgd   Cp	1415	291	2	145.5	137	40.4	.43	• 1			660		, ,	70 days
BETA: Pure Beta emitters COMPOSITE: Beta Bkgd cpm - Beta Bkgd cpm - Beta Bkgd cpm - Beta Bkgd cpm - Beta Bkgd		87	2		54.0	BKGD	.43	1.1	Į.	.95	뇞	1		
pm - Bkdg - dpm Alpha cpm - bkgd - dpm Beta - bf vear	.PHA:				Pu	Beta	mitter	s	ខ	MPOSI7 com -	ri Ba	77		- dom Be
1130 V TO Y O	E E	dg.		1 Alpha	1   1	1	11 1	pm Bet		o x bf	X SS X	af		l 1

ATION:

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SAMPLE COLLECTION DATE: 2/	ATE: 2/
TIME OF COLLECTION: 1100	1100
SUSPECTED ISOTOPE:	Uniden

SUSPECTED ISOTOPE: Unidentified	TES	
CTED ISOTOPE:	40 MINUTES	10 M <sup>3</sup>
SUSPE	TOTAL TIME	MINUTES = VOLUME
	MINUS TIME STARTED 1100	M <sup>3</sup> /hr <sub>X</sub> TOTAL TIME 40 MINI
	RUN: TIME STOPPED 1140 M	COLLECTION RATE 15 M <sup>3</sup> /hr 3
	F RUN:	COLLECT

FIH OF RUN:

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/hr X TOTAL	COUNTS	.NIW	SINDOS
5 M <sup>3</sup> /F	GROSS C	UTW SW	SIANOS

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CATION: MUSE	MUSEUM OF SCIENCE AND	IENCE	Η	NDUSTRY 11	14				SAMPL	DE COLLEC	SAMPLE COLLECTION DATE:		3/2/77
									TIME	OF COLLE	COLLECTION: 1	1030	
									SUSPECTED		ISOTOPE:		
NGTH OF RUN:	TIME STO	STOPPED	1110	MINUS I	TIME STARTED	}	1030	TOTAL	LIME	40	MINUTES		
LUME: COLLECTION	TION RATE	09 E	15 M <sup>3</sup> /hr	hr X TOTAL	L TIME	40	MINUTES		= VOLUME	10	IK <sup>3</sup> 3	}	
			GROSS	COUNTS	BKGD	NET	]		40				
AMTT GNA ST	- 400 B	SINA	AE MAIN.	'NIW	MIN	'NIW		STON RACTO	MOI LANOSE	dOTOMA N	SNOLT!		VCLINILA
UNI	OO TATOL	1105	SINDOS III	"LNITOD	SINDOS	(FE)	CROMETRY.	SAMP,	TV 37	NISIA	NIW AZA	•	OECAY TO
1119	1555	2	77.5	0.3	.77.2	.43	1	17.	8.	2913	291	ರ	9 min
1259	25	2	12.5	0.3	12.2	.43	1	.77	.8	460	76	ಶ	109 min
1300	0	2	0	0.5	BKGD	.43	1	.77	8.	BKGD	BKCD	ಶ	50 days
1117	853	2	426.5	+ 77.5	266	.43	1.1	1	.95	5924	592	8	7 min
1257	284	2	142	83 + 12.5	46.5	43	1.1	1	.95	1035	4	В	107 min
1300	64	2	32	53.5	вкср	.43	1.1	1	.95	ВКСО	BKCD	В	50 days
PHA: cpm - Bkdg	640	-	B	BEIA: Pure	Pure Beta emitters - Bkgd	mitter	, ,	ָּט ט	COMPOSITE:	Beta ta Bkgd	ermina Alpha	ttion cpm	

					T (1)(1) T 157	77 77							
				·	AIR SAMPL	SAMPLE DATA			!		,		
CATION: MUSEUM OF	EUM OF SC	SCIENCE AND	AND INDUSTRY		E-117 South	ţ.			SAMPLE	LE COLLEC	COLLECTION DATE:		3/1/77
						į I			TIME	P.	COLLECTION: 10	1026	
		<b>!</b>							SUSP	SUSPECTED ISO	ISOTOPE: Uni	ident	Unidentified
GIH OF RUN:	TIME	STOPPED		MINUS	TIME STARTED	TED	1026	TOTAL	L TIME	40	MINUTES		
TTOO : SWITE	COLLECTION RATE		15 M <sup>3</sup> /1	/hr X TOTAL	AL TIME	40	MIN	MINUTES	= VOLIME	C	ج ۳		
		3									<b>:</b>		
			GROSS	COUNTS	BKGD	NET	l		· ita				
			12				_	TO PL		QOLO •	SAV		ZZZ,
E AND TIME OF	S.I.A.DO.	Silvo	WIW THE	'NIW	NIN	'NIN	\	AHTT ASSA	ASORP.	Va D			ATTO A
COUNT	O TAN		S.I.N.	"LAU	SIA	`	STETA!	VOSY	V FT	~VQ	W/W/		T AV.
	TO I	100	1000	200	200	\ \ \	N A	OVVS	AVIM	SIO			DEQ
1111	149	2	74.5	0.5	74.0	.43	1	.77	8.	2792	279	ಶ	5 min
1251	59	2	19.7	0.5	19.2	.43	Ι	.77	8.	724	72	ಶ	105 min
1300	0	2	0	5.0	BKGD	.43		77.	8.	BKGD	BKGD	ರ	51 days
1113	835	2	417.5	79 +74.5	264	.43	T.T	H	.95	5879	588	82	7 min
1253	426	2	142	79 +19.7	43.3	.43	1.1	ıi	.95	964	96	മ	107 min
1300	42	2	21	53.5	BKGD	.43	1.1	1	.95	BKGD	BKGD	В	51 days

TION: MUSEUM OF	IM OF SCIENCE		AND INDUST	AP H THIE				1					
									TIME 0	OF COLLECTION:		1100	
T. T.									700000	man Teomode.		ident	Toidentified
The state of the s									SUSFECTED				
{		CTOPPED	1162	MINUS II	TIME STARTED		1100	TOTAL	TIME	42	MINUTES		
TH OF KUN:	ात्र वासार	1	 										
JME: COLLECTION	TION RATE	15	M <sup>2</sup> /hr	I X TOTAL	TIME	42	MINUTES		= VOLUME	10.5 N	ايخ		
		09					-					-	
	) (		GROSS C	COUNTS	BKGD	NET		¥0,	350				/ 1/4
			/					TO VY	OZZ	OZO	* SNO		IAI
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COUNT	TVIO	1000	SINDO	INDOS	SINDOS	TONO)	SKOMB.	BACKS	OUNIM	VISIA		•	TOTAL STATE
	7	<b>ပ</b> ြ		,   									l .
0711	312	2	156	0.2	155.8	.43		17.	∞.	5879	560	ಶ	7 min
1147	216	1	1 00		73.3	67	<b></b> 1	.77	∞.	879	84	ರ	116 min
1338	47	7	23.3	7:0	25.57						400		
1300	0.	2	0	0.5	ВКС	.43	-1	77.	ω.	BKGD	BKGD	ಶ	o I
1151	1526	2	762	57.8 + 156	549.2	.43	1.1	-	.95	12231	1165	82	9 min
TCT1	237	6	168.5	57.8 + 23.5	87.2	.43	1.1	<del>1</del>	.95	1942	185	В	118 min
1340	25/	1	, I		0.00	?	-		95	BKGD	BKGD	α.	36 days
1300	42	7	21	53.5	BKGD	7	7	ı				1	
PHA:				Pt	t a	emitters	Ŋ	ອ	COMPOSITE:	beta ta Bked	dererminacion + Alpha cpm	CDB	
cpm - Bkdg	dg	map =	m Alpha	CDm	DKKG	II I	dpm Beta	:			1		apm ber
				3.1	22. 40 47. 43.	and f			o x bt	o x hf x sax wat	3 <u>T</u>		